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AUTHOR: Rylov, Yu. A.

TITLE: On the relative energy of a static centrally symmetric gravitational field

PERIODICAL: Moscow. Universitet. Vestnik, Seriya. III. Fizika, astronomiya, no. 6, 1962, 45 - 55

TEXT: Energy and momentum of a static centrally symmetric gravitational field with respect to the center of symmetry of the system are calculated by a method devised by the author (Yu. A. Rylov. Vestn. Mosk. un-ta, ser. fiziki, astronomii, no. 5, 1962) from the relativistic field of gravitation $Q^{\alpha}_{\beta\gamma} = \gamma^{\alpha}_{\beta\gamma}(x) - \Gamma^{\alpha}_{\beta\gamma}(x, x')$ (1). $\gamma^{\alpha}_{\beta\gamma}$ are the Christoffel symbols in space-time V_4 in a certain system of coordinates K, $\Gamma^{\alpha}_{\beta\gamma}(x, x')$ are the Christoffel symbols in plane space E_x. These two spaces are tangent at the point x' of the coordinate system $K_{x'}$. This relativistic field of gravitation is a two-point tensor describing the gravitational field at

Card 1/4

the point x with reference to the field at the point x'. First the world function corresponding to the live element $ds^2 = e^{\nu}dt^2 - r^2(d\theta^2+\sin^2\theta d\varphi^2) - e^{\lambda}dr^2$ (11) is calculated, where $e^{\nu} = 1 - 2\xi$, $e^{\lambda} = (1-2\xi)^{-1}$, $\xi = \alpha/2r$. α is the radius of gravitation, matter is assumed to be in the region $r < R$. Then the relativistic gravitational field

$$Q^0_{03} = -\frac{2\xi}{r}\left(d - p + q - \frac{3}{2}\right), \quad Q^1_{13} = \frac{\xi}{r}(d + 2p - 1),$$

$$Q^2_{23} = \frac{\xi}{r}(d + 2p - 1), \quad Q^3_{00} = -\frac{h' - 1}{r}\left(1 + N\xi - \frac{h'}{h' - 1}\xi\right), \qquad (28)$$

$$Q^3_{11} = \xi(d + 2p + 1)r\sin^2\theta, \quad Q^3_{22} = r\xi(d + 2p + 1).$$

is calculated by means of the transfer tensor

$$P^{\cdot\beta}_{\alpha'\cdot} = -g_{\alpha'\sigma'}(x')G^{\sigma'\beta}, \quad P^{\cdot\alpha'}_{\beta\cdot} = -g^{\alpha'\sigma'}(x')G_{\sigma'\beta},$$

(9). Finally, the four-momentum

$$P_{\beta'} = \lim_{r_0 \to \infty}\int_0^{2\pi} d\varphi \int_0^{\pi} \Lambda H^{00}_{\beta'} r_0^2 \sin\theta \, d\theta.$$

(29) is obtained by means of

Card 2/4

$$P_{\beta'} = \int_{\sigma} H^{0l}_{\beta'} \sqrt{-D_x}\, d\sigma_{0l} = \int_{\sigma} \Lambda H^{0l}_{\beta'} \sqrt{-g}\, d\sigma_{0l},$$

(5) and

$$\Lambda H^{0l}_{\beta} = \frac{1}{2\varkappa} \{\delta^{0}_{\beta}(Q^{\alpha\cdot l}_{\cdot\cdot\alpha} - Q^{l\cdot\alpha}_{\cdot\cdot\alpha}) - \delta^{l}_{\beta}(Q^{\alpha\cdot 0}_{\cdot\cdot\alpha} - Q^{0\cdot\alpha}_{\cdot\cdot\alpha}) + Q^{l\cdot 0}_{\cdot\beta\cdot} - Q^{0\cdot l}_{\cdot\beta\cdot}\},$$

(6), where

$$H^{03}_{\overline{0'}} = \frac{1}{k'} H^{03}_{0},$$

$$H^{03}_{\overline{1'}} = -\frac{\sin\varphi}{r\sin\theta} H^{03}_{1} + \frac{\cos\theta\cos\varphi}{r} H^{03}_{2} + \sin\theta\cos\varphi\, H^{03}_{3},$$

$$H^{03}_{\overline{2'}} = \frac{\cos\varphi}{r\sin\theta} H^{03}_{1} + \frac{\cos\theta\sin\varphi}{r} H^{03}_{2} + \sin\theta\sin\varphi\, H^{03}_{3},$$

$$H^{03}_{\overline{3'}} = -\frac{\sin\theta}{r} H^{03}_{2} + \cos\theta\, H^{03}_{3}.$$

(30). (5) is integrated over a sphere of radius r_0 at constant t; therefore it is only necessary to know the asymptotic behavior of $Q^{\alpha}_{\beta\gamma}(\vec{r}, t, \vec{r}', t')$ at $t=t'=0$, $r'=0$, $r \to \infty$. It is shown that the energy of the gravitational field in

relation to the point $x' = 0$ is negative.

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